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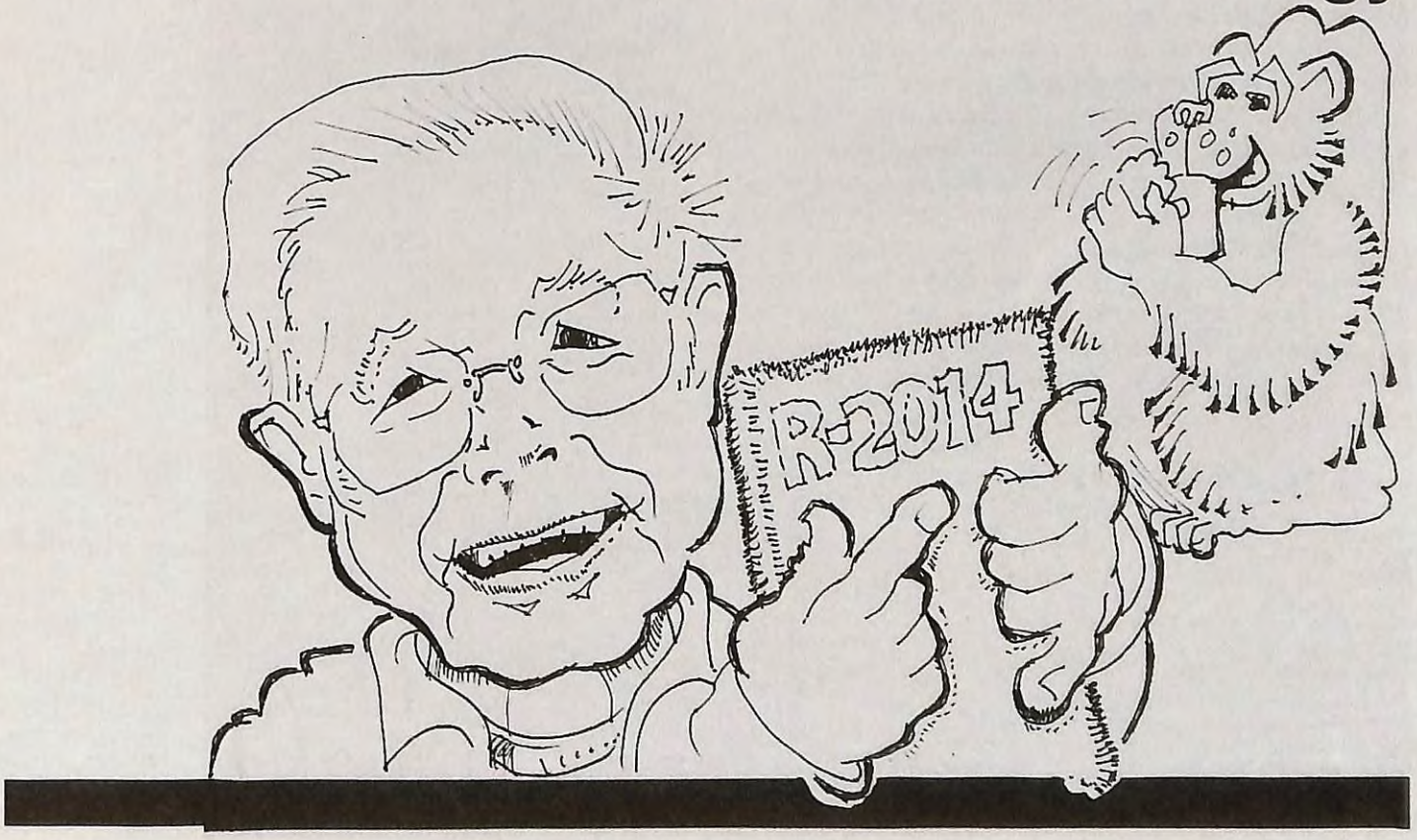
Harold Orr on the Cost Of Insulation and Energy



From the Editor . . .

Construction is an industry with a long and honourable history. Next to food production, construction is one of mankind's most important industries. We can do without most of the stuff we are surrounded with today, but we can't do without shelter.

The industry has emerged from a long and proud tradition of craftsmanship. Despite changes in technology, development of new materials, tools and construction technologies, and standardized factory-made components, it still relies on the craftsmanship on the job site. That is why we really need to enhance training as well as continue with research to deal with issues as they arise and to avoid unintended consequences of the new materials, designs and technologies in use today.

Because of the diffuse nature of the industry, and despite the mass produced components and products we rely on, every building we build is unique – a prototype. That is why this industry, perhaps more so than others, very much relies on building codes.

Codes are meant to set out minimum requirements for how a building is to be constructed. Unfortunately, too often they are relied on as a 'how-to' manual, and as a benchmark of quality. But codes are there to define minimum standards, to set the floor for the least that can be built that will provide a building that is healthy and safe for the occupants.

Codes are reactive – they are changed as required to meet community objectives and address issues that users raise about new materials, technologies and interpretations. We need to encourage construction that goes beyond a literal interpretation of the code, not just minimum compliance.

This also means that all involved, including building officials, will be challenged to properly interpret enhancements to minimum requirements. There are many ways to build better. Some good options are not pursued because some building officials find them outside their comfort range so they refuse to allow them. It is understandable when a builder holds back because of a lack of understanding, as they are directly responsible to the owner. But it is disturbing when building officials, who generally have more access to technical resources and are expected to have a better understanding of building science and technology, are not able or willing to evaluate and accept new approaches, even when they are explained and presented by professionals.

It is also disheartening that there is little support among building officials for helping builders improve their product, despite talk to the contrary. I've observed how explanatory information describing changes to code requirements have focused on very narrow legalistic interpretations with little appetite for discussion of possible enhancements for better building practices. One only has to look at the various bulletins being developed for the latest changes to the building code. The focus is on how little you need to do to comply with the changes and very little on how simple it might be to significantly improve construction, even if it means doing a bit more than the code minimum.

While we need to be clear about what the minimum requirements are, we must not loose sight of the objectives – to build better buildings. We should be encouraging better construction practices for all buildings, and not just focus on how to meet the minimum code requirements.

Richard Kadulski,
Editor

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Cost Of Insulation and Energy

By Harold Orr

Traditionally, the optimum amount of insulation has been calculated by looking at the last increment of insulation added and calculating the amount of energy that the insulation will save. When we reach the point where the savings are less than the cost of the insulation, we are at the optimum point.

I have always felt that this was wrong because adding more insulation also reduces the required size of the furnace and air conditioning equipment, which we didn't take into account. The cost should also include the cost of the heating system. Simply stated, the optimum amount of insulation is that amount which minimizes the combined cost of the installed insulation and the cost of the fuel to heat the space PLUS the cost of the heating system, PLUS the cost of the environmental damage. Currently this is estimated to be $200 / Tonne of CO_2.

I think that for every dollar spent on insulation installed you should likely reduce the cost of the heating system by between $0.50 and $1.50. The lower number is likely where little additional air sealing has taken place and the larger number is where serious air tightness is achieved. At $1.00 per $1.00 we have a direct trade off between insulation and heating system, and insulation does not wear out while a furnace will last 25 to 40 years.

The problem is that small furnaces are not available at half the price of larger conventionally sized furnaces and it is not well recognized that point source heating works remarkably well in very well insulated buildings. One of the possible solutions is to use a high efficiency instant hot water heater with a separate heating coil to provide in-floor heating.

At $200/Tonne of CO_2, the cost per home is about 110% of the cost of the natural gas used.

Costs for disasters should also be included. A well-insulated house that retains its heat in a cold climate when the power goes off due to storms has huge benefits that are not considered.

One example I am aware of is that of a commercial building – when the heating system failed during a very cold spell, the sprinkler system froze because of inadequate insulation and resulted in $10,000 clean-up and repair costs.

On the other extreme, I super-insulated a four-suite apartment in Saskatoon and one of the tenants complained that her heating unit was not working when the outdoor temperature was in the range of -20°C. She was cooler than she wanted but she was not suffering since heat from the other three suites kept the suite temperature between 15° - 18°C. The problem was solved by installing new batteries in the thermostat.

How much insulation should we be installing in the walls? If you are including only fuel and insulation costs you should be installing about R-40. If you include the cost of the heating system you should be installing about R-60. If you include carbon reduction, I suspect you should be installing about R-85. These figures are for Saskatchewan where we have 6,000 Degree Days °C.

The use of the Prairie Double Wall has some very definite advantages over more conventional construction for reducing energy consumption. First it moves the air/vapour barrier 3 ½" away from the inside of the home, so it is away from the electricians, plumbers, and drywall people, and is not damaged by these trades. As a result the air barrier on the walls can survive without damage that other methods impose on the air barrier.

Secondly, the Prairie Double Wall uses thin sheet material on the top and bottom of the wall to hold the inner and outer walls together. This makes the wall higher than a convention wall by twice the thickness of the sheet material. We originally used 5/16" plywood but now we usually use 8mm OSB. In any case the walls are between 5/8" or 16mm higher than a conventionally framed wall. This raises the floor to ceiling height by this amount so if the ceiling air/vapour barrier and drywall are installed before the interior partitions are installed, the air vapour barrier can be installed in large sheets with no breaks and the ceiling drywall can also be installed in large pieces.

This technique saves a lot of time and materials in installing ceilings, and I think it should be used in conventional construction because of the savings. I have seen two drywall people install a

Harold Orr is a retired building scientist from Saskatchewan. He was a driving force behind the Saskatchewan Conservation house that set the groundwork for low energy housing in Canada and around the world – starting with the R-2000 program. The message that Harold presented a third of a century ago is still current today.
This past year Harold has received awards from the Passive House Institute

1,400 ft² ceiling in about 3 hours. In low-energy housing, however, the use of large sheets of air/vapour barrier without breaks results in much tighter ceilings and with much less effort.

Thirdly, the Prairie Double Wall makes space for large amounts of insulation very inexpensively. The only additional cost between a minimum and a maximum wall is the cost of the width of the OSB top and bottom plates and the insulation added between the minimum and maximum walls. The minimum double wall is likely an R-36 wall and the difference in cost between this wall and an R-60 wall is likely about $0.75 / sq.ft., and an R-85 wall would be about $1.50 / sq. ft. This is using the least expensive mineral fibre insulation and I would not recommend the least expensive insulation. This would be approximately $1,000 for the main floor walls of a 1,500 ft² house – a negligible extra cost on a $300,000 house.

Fourthly, the double wall provides a very good structural base for the exterior wall finish. More conventional construction either has little or no support for the exterior finish or it has major thermal bridges through the insulation. 2x8, 2x10, or 2x12 studs have serious thermal bridging, while Larson trusses and wooden "I" joists on the outside of the structural wall are very difficult to insulate with batt insulation because batts are not made for the space between trusses or joists.

Finally, the electrical wiring in the exterior walls of the house does not need to be wrapt or placed in airtight electrical boxes to make it air tight since the air vapour barrier is outside of the inside wall. This saves at least one half the labor of installing the wiring in the outside walls and the work can be done by less skilled workmen.☼

Closed Cell Foam Insulation R-Values

Closed cell insulation foam products use a variety of blowing agent gases in their production. When measured at time of manufacture of the foam, the R-value can be quite high. However, over a period of time, some of the blowing agents migrate out through the cellular matrix to lower the R-value. That is why Canadian testing standards require that a determination of the long-term thermal resistance be used. This corresponds to the average thermal resistance of the full thickness of a product over a fifteen-year service life. This is known as the Long Term Thermal Resistance or LTTR.

It is important to keep this in mind because, although the test standards used in the US require testing to the same Canadian standard, the reporting requirements are not the same. In the US they do not report a LTTR value, so US product literature will have a reference to aged R-values, but at 90 days.

How important is that? One example I can cite is for a closed-cell spray applied foam insulation. The manufacturer's US data sheet for the spray foam insulation shows an R-value of 6.5 per inch thickness, while the same product has a Canadian LTTR value of 5.5 per inch. The information is on the manufacturer's web site – you only need to turn on the Canadian site icon, rather than the default US site, but this is a subtlety that doesn't always get noticed. The assumption is that technical data is straightforward and universal. It creates much confusion among designers, builders and even the insulators, who may conveniently overlook this information to use a bit less product and be more competitive.

One aspect of foam products that adds a confusing aspect is that aging of the material, and the diffusion of gasses out of the foam, is related to thickness. This means that the average LTTR per unit thickness increases slightly with thicker materials. The standard reporting for R-values is for a 2-inch (50 mm) thickness, but with thicker applications, the R-values may be greater. Some manufacturers will provide additional information about LTTR values for their product at thicknesses beyond the 50 mm thick sample.

In Canada, the protocols for calculating the LTTR are laid out in the CAN/ULC-S770- 03, "Standard Test Method for Determination of Long-Term Thermal Resistance of Closed-Cell Thermal Insulating Foams" which has recently been updated. When determining how much material, and what the R-value is, always look for the LTTR value. ☼

Polyiso R-values Revised

The Polyisocyanurate Insulation Manufacturers Association recently announced that its QualityMark-certified R-value program is being updated to incorporate updated LTTR testing. As a result, R-values for poly-iso are going to decrease from current values by about 7%.

The new LTTR value for one-inch thick rigid polyisocyanurate roof board insulation with a permeable facer will be 5.7 (RSI=1.004) compared to the currently published design specification LTTR value of 6.0 (RSI=1.057).

Technical Standards (2)

We rely on standards when making decisions about products. Product literature and specs often reference a list of standards to which the product has been tested or complies with. A long list of impressive standards says to most of us that the manufacturer has done due diligence, and the product must be acceptable. However, we seldom really understand the true nature of the standards, and especially their scope.

We introduced the subject of standards in Solplan Review No. 173. We wanted to stress the importance of recognizing the limitations of each standard and raise the awareness that there may be a number of standards that essentially are addressing similar issues, but may have their own quirks or benchmarks. This is especially the case when looking at international standards. Different countries may have different ways of looking and measuring similar characteristics, and come to seemingly different results.

One item we highlighted was HRV performance. We mentioned how a Swiss HRV being marketed in North America (the Zehnder) must be modelled for EnerGuide certification, and because of the testing done by the manufacturer is not done at -25˚C, it cannot be used for Energy Star certification.

Not surprisingly, we received a couple of letters on the subject. One pointed out that the unit is listed in the HVI directory so it has third party test results. That is correct, but a close look at the test results in the HVI directory shows that it is only tested at 0˚C. By itself that's acceptable but the CSA standard testing done in Canada, and required by EnerGuide and Energy Star New Homes sets two temperature conditions for testing – at 0˚C and -25˚C.

The two temperature points may be arbitrary, but as with all standards, the test conditions are established so that various products tested to the standard can be compared on an equal footing. The criteria established by the committee drafting the standard are generally meant to be somewhat representative of the conditions that the product will experience either under average or extreme conditions.

When the Canadian testing standard for HRVs was developed, it recognized that the units will be operated in a cold climate, so operation at cold weather conditions and the defrosting of the unit will have an impact on the performance. That is why the -25˚C test point.

In the early days of development of HRVs in Canada, some manufacturers relied on pre-heaters for the incoming outdoor air as a means of addressing the defrost issue. However, it was quickly discovered that a much simpler, more reliable and economical defrost strategy was to simply allow indoor air to recirculate within the HRV unit for a short period to melt the ice. The length of time the unit shuts off the incoming airflow is relatively short, and does not compromise the indoor air quality.

In Europe, recirculation of indoor air is not allowed as it is perceived to compromise indoor air quality. As a result, some of their HRVs rely on pre-heating incoming cold air so that frosting will not happen. The Zehnder is HRV is designed with European standards performance in mind so they don't test to -25˚C.

Zehnder has indicated that the Canadian testing protocols limit their approach to compliance with North American testing requirements for their equipment, and does not allow them to showcase their performance favourably. Testing they had done by Exova laboratories with Zehnder's ground source pre-heater suggested their units achieved up to 99% heat recovery. However, the testing process used was their own self-designed protocol to simulate North American conditions, so cannot be compared to other units tested to the CSA standard.

The use and misuse of standards and standard testing procedures applies to many products. One of the more outrageous examples relates to radiant insulation products. Those promoting radiant insulation products have been using their own testing procedures and interpretations to claim outlandish insulation properties for years. Radiant barriers are a product that, when used use in specific applications, do have an effective performance benefit, but there are few appropriate locations for them in normal construction. They are the universal insulation product their promoters suggest.

It is important to understand the scope of tests and standards as not all standards are equivalent. You can't always say that one standard is better than another.

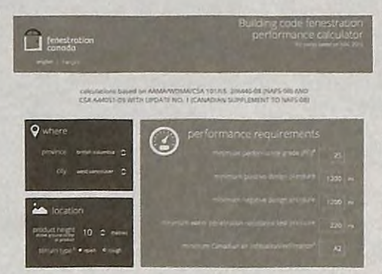
You Asked Us About: New Window Compliance Requirements with NAFS-08

My window supplier has told me that with the new building code changes with respect to windows, it appears as if we will need to engage an architect or engineer to determine which type of window will be best suited to avoid water penetration in BC. Is this true?

GV, Salmon Arm, BC

You raise a good question. The intent of the code requirement is that windows be properly designed and tested by the window manufacturer. The window supplier must have their standard units tested, as per the NAFS windows standard; once their products have their certification labels - it's all that's required. They only need to retest with whatever frequency is required by the standard and certification agency they use or when the window design is modified.

There is no need for a professional to have to review or sign-off on such products. Any required engineering is done by the window manufacturer. This may be something new for some BC window manufacturers; there are a number of small window suppliers that may not have had a lot of technical support in the past.



Fenestration Canada has developed a web-based code calculator to make it easy to determine the required performance requirements. http://codecalc.fenestrationcanada.ca

One significant new change with the introduction of the new standard is that combination windows now have to be tested by the manufacturer as a whole unit – in the past it was only a couple of standard units that were. This change captures the mullions that link together several units into one larger unit.

Site-built windows - which are the rare cases where a builder might use some custom glazing (e.g. some high-end custom homes where the timber framing forms part of the window system) are exempt from the requirement (although the IG glazing panel itself would still have to be more than just a single sheet of glass).

Note that a disassembled manufactured window (i.e. bringing a standard unit to the site in pieces and installing the frame and the glass panels on site in the style of an IKEA product assembly) is not considered to be site-built.

However, there is a new requirement for more specific performance requirements. NAFS-08 identifies differing levels of performance that will vary depending on a number of site-specific conditions. It is up to the purchaser or specifier to select the appropriate level of performance required depending on climatic conditions, height of installation, type of building, and type of glazing unit. The performance classes range from PG20 to PG100.

It would be pretty well impossible for a manufacturer to be responsible to assess the site-specific conditions of every project. It would be the same as if an insulation manufacturer were to be responsible for a builder purchasing R-12 insulation when the code requires R-20 for a specific application. That is why the licensed builder must bear the responsibility to specify the products that he/she will use to build a code-compliant structure. Sometimes, it may be necessary to have a better performance grade than the minimum required – only the builder/designer/specifier will know that – not the supplier.

The job of the supplier is to ensure that the windows supplied for you have the proper certification to match the performance class that you have specified. The purchaser has to ensure that the performance classes are clearly labelled on their window schedule.

We can expect that most authorities will develop guidelines for standard low-rise construction in their jurisdiction, just like they have information about climatic loads.

Fenestration Association of BC has developed a NAFS Quick Reference Guide that should assist all users. We are reproducing it with permission.

Terrain definitions in Building Code

Open terrain is level terrain with only scattered buildings, trees or other obstructions, open water or shorelines.

Rough terrain is suburban, urban or wooded terrain extending upwind from the building uninterrupted for at least 1 km or 20 times the building height, whichever is greater.

Fenestration BC has prepared guidelines on the Use of CSA A440S1-09 (Canadian Supplement) for Determining Fenestration Performance Grades in British Columbia. The document, along with much other useful information, is available on their website: *www.fen-bc.org*

FENESTRATION ASSOCIATION OF BC

NAFS QUICK REFERENCE GUIDE

February 2014

Covers **Windows, Doors, Tubular Daylight Devices and Skylights** in one Harmonized Standard. These products must conform to NAFS and the Canadian Supplement

NAFS - NORTH AMERICAN FENESTRATION STANDARD 2008
(Officially AAMA/WDMA/CSA 101/I.S.2/A440-08)

Note: NAFS does not include interior doors and windows, vehicular access doors (garage doors), curtain wall, storefront, storm doors, storm windows, commercial entrance systems, sunrooms, revolving doors, site built door systems and commercial steel doors

Note: For commercial products used in a residential application, registered professionals may be required to ensure compliance to codes and standards

Officially adopted by National Building Code of Canada 2010 and BC Building Code 2012

CANADIAN SUPPLEMENT CSA-A440S1-09

Increasing performance

ALL PRODUCTS RATED TO SEVERAL LEVELS OF PERFORMANCE:

PERFORMANCE CLASS*:
R – min. 15 psf
LC – min. 25 psf
CW – min. 30 psf
AW – min. 40 psf
(Minimum Gateway Requirements)

PERFORMANCE GRADES:
A single number achieved for a class that represents structural and water performance (e.g. PG-25, PG-30, etc.)

TESTING REQUIREMENTS:
Part 3 and Part 9 Buildings-Window tests required – see Table 27 minimum sizes for each product type

For Part 3 Buildings - determined by Architect
For Part 9 Buildings - determined by Building Dept.

Test results - Strict Labelling requirements, each window/door requiring permanent and temporary labels

Must laboratory test doors, individual windows, combination windows (mulled) and multi lite windows with integral mullions

CANADIAN SUPPLEMENT CSA-A440S-09 USED TO DETERMINE PERFORMANCE GRADES (Use Checklist on page 21 to determine performance requirements)

Permanent labels must indicate at least the name of manufacturer and can be etched into the glass or affixed to the product frame (i.e. must be permanently visible after installation)

Performance labels can be temporary and must indicate both the primary designator (class, performance grade and size tested) and secondary designator(design pressures, water test pressures and air infiltration/exfiltration level denoted by A2, A3 or Fixed)

Use simplified method to determine:
- Wind Pressure (HWP)
- Water Pressure (DRWP)
- Test Pressures
- **Performance Grade and Secondary Designators** required based on the above

Note: only products installed in Canada still require the A rating (either of A2, A3 or Fixed) for infiltration / exfiltration

Performance Grade is dependent upon:
- Building height
- Geographical Location
- **Open or Rough Terrain**
- Building must be on level terrain to use the simplified method of wind load determination

Note: Each Performance Class has a range of product types, as many as 30 in all (e.g. awning (AP), casement (C), fixed (FW), etc.). **Product selection (i.e. what class) is based on the performance requirements of the project**

To ensure compliance to NAFS:
- For each project determine what Performance Class and Grade your product will need to meet – consult building department for Part 9 buildings; review architectural window schedule, project specifications, consult architect and window engineer for Part 3 buildings. Check Canadian Supplement page 21, Figure A.1 Checklist
- Ensure your product meets the required class and grade by way of testing
- Ensure your products have been tested to fully anticipated worst case sizes and configurations that may occur on a project
- For Part 9 Buildings – affix permanent & temporary labels to each window
- For Part 3 Buildings – permanent labels at each window; indicate all performance levels on stamped shop drawings which may substitute for temporary labels (i.e. for window wall on high-rises) although this has not yet been confirmed

NAFS 2008

Canadian Home Builders' Association

Technical Research Committee News

Window Standards Building Code Rumours

There has been much confusion about the regulatory status of new NAFS-08 requirements for windows. Any rumours that NAFS requirements are being delayed are simply rumours. Fenestration Canada reviewed the cross Canada situation, and notes that as of March 1, 2014, compliance with NAFS-08 and CSA A440S1-09 are required for all installations in BC, Saskatchewan, Manitoba, Nova Scotia, Yukon, Northwest Territories and the city of Moncton.

In Ontario NAFS-08 and CSA A440S1-09 are required for all installations with building permits issued after January 1, 2014. If the building permit was issued before January 1, 2014 the older standards apply, provided ground is broken on the job within 3 to 6 month of the date of issue of the permit. This time frame will be defined by the local building officials.

Prince Edward Island and Newfoundland have implemented the code which includes NAFS 08 but are not currently enforcing it. Nunavut does not have a building code act in place, but any federally funded projects will have to meet the National Building Code of Canada 2010, and NAFS-08 and CSA A440S1-09 requirements.

Alberta, Quebec and New Brunswick are all working with older codes and standards at this time.

Building Codes

Climate change means that climatic loads are changing. As a result of the severe winter of 2013 with near record snowfalls in some regions the Codes Centre is looking for information on building failures as a result of snow loads. Anyone who has knowledge of such failures should send information to CHBA who will forward the information.

High Cost of Code Documents

A constant comment received by the Codes Centre is that the high cost of purchasing codes means that many Code users don't actually have a current copy of the Building Code. This is acknowledged both at the Canadian Codes Centre and in the provinces.

The challenge is that, according to the business model currently in place, the development of the codes and standards is done entirely on a cost recovery basis. Even with the immense amount of time that volunteers contribute to the process, there is a considerable amount of staff time involved in the development and maintenance process. These expenses must be covered by the sale of the code documents, which leads to the pricing structure in place.

For the price to be lowered, making access easier at a lower cost, there would need to be a significant shift in political will to change the business model.

Reducing Radon in Homes

Recent scientific research by Health Canada estimates that about 3,000 lung cancer deaths annually in Canada could be linked to exposure to indoor radon. According to a national survey, about seven percent of Canadian homes have radon levels above Health Canada's guideline concentration. As a result, the National Research Council and Health Canada have undertaken a multi-year laboratory study to develop practical and cost-effective solutions to minimize health risks from radioactive soil gases and to provide guidance for prevention and mitigation of problems.

Key questions being explored include:

Will radon discharged from mitigation exhaust fans re-enter neighbouring buildings? This is especially important in high-density developments where outdoor air intakes, windows and doors could be close to discharged air.

To what degree can membranes and concrete assemblies with reduced permeability to radon reduce radon concentrations in basements or first floors?

Will a fan, triggered by indoor radon and air pressure differences, reduce indoor radon concentrations in basements or first floors and save energy at the same time?

Will the negative pressure created by a radon depressurization fan have any impact on the risk of backdrafting from combustion appliances in the basement, and of pollutants migrating from an attached garage?

The intent is to prepare the results in the form of practical cost-effective solutions and guidance for builders and homeowners, and in reports to national code committees.

Ontario Building Code

Even as the latest building code energy requirements are introduced, Ontario has signalled where energy standards are going in the future. New requirements in 2017 will reduce the energy consumption of houses another 15%. As a result, new Ontario houses built in 2017 will consume 50 per cent less energy than homes built before 2006.

Announcing the direction of coming code changes will make it easier for builders and purchasers to plan ahead. It may spur some to look at options that exceed today's minimum requirements.

Combination Heating and Hot Water Systems

Effective April 1, 2014, any system providing forced-air space and domestic water heating will need to be tested to *CAN/CSA P.9-11 Test Method For Determining The Performance Of Combined Space And Water Heating Systems* (combos) in order to be recognized by the Energy Star for New Homes program.

Recently, Navien has achieved a CAN/CSA P.9-11 rating for its NPE-240A condensing tankless water heater system with a SunTherm MMVE air handling unit for combined space and water heating.

Canadian Wood-Frame House Construction

CMHC has updated its Canadian Wood-Frame House Construction. It is an introductory book for understanding and applying wood-frame house construction principles and has been generally organized to correspond to the construction sequence for a typical house. Earlier editions have been translated into many languages, and are used around the world.

This edition has been updated to reflect the residential requirements of the 2010 edition of the National Building Code of Canada (NBC), including new energy efficiency requirements in the 2012 Interim Changes to the 2010 NBC (section 9.36).

Other changes have been made to bring this guide in line with current building science research, construction methods and construction materials. Information about the functions of the building envelope has been moved to the front to reflect the importance of this topic and the need to consider it early in the planning process. Also included is practical guidance that profile opportunities to make a house more sustainable by increasing energy efficiency, supporting healthy indoor environments, reducing environmental impacts and resource consumption, and addressing affordability.

Electronic copies are available for download, free, from the CMHC web site:

www.cmhc-schl.gc.ca

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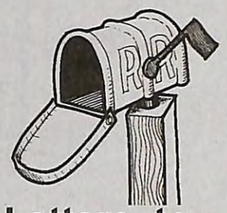


Letters to the Editor

Re: Built Green Canada

In response to concerns raised about Built Green Canada (by RH of Victoria, BC, Solplan Review November 2013, and the Editorial (Solplan Review September 2013):

Thank you for raising your concerns about Built Green Canada. It opens up the opportunity for discussion, information-sharing, and informed opinions. 2013 marked the 10th anniversary of Built Green Canada, and in the last couple of years leading up to this milestone, there have been a number of tough questions that have had to be addressed as the organization matures.

It would appear there is a misunderstanding regarding our EnerGuide requirements. To be clear: Built Green requires an EnerGuide rating, which forms the first of two measured requirements of a BUILT GREEN® home. Our program is based on a dual-label process with the first being the EnerGuide rating. The BUILT GREEN® Checklist forms the second measured requirement of the home and its components are based on the "House as a System" approach. This second measurement is determined by selections chosen from the checklist.

To clarify, the "de-coupling" comment: For the energy component of the BUILT GREEN® program, builders have the option of using the EnerGuide Rating System (ERS), or choosing points from the Envelope and Energy Systems section of the BUILT GREEN® Checklist; regardless, the home must be modelled and tested in the EnerGuide Rating System, and receive an EnerGuide rating. Some builders choose this latter scenario to gain more points for a possible higher BUILT GREEN® level seal. If this option is chosen, after the completion of the blower door test (to confirm the EnerGuide rating), and the completion of the Built Green checklist selections, the home receives its BUILT GREEN® level seal accompanied with its EnerGuide label.

In summary, yes, the EnerGuide rating and the BUILT GREEN® seal are segregated; however, a quick review of the Energy and Envelope section would show it is difficult for a home not to achieve a superior energy rating over building code, should they choose to count checklist points and not their mandatory EnerGuide rating, toward their BUILT GREEN® certification level. The Envelope and Energy Systems section of the BUILT GREEN® Checklist go hand-in-hand with ERS, such that if the builder hits the Gold level points required in this section, on average, homes in Alberta and British Columbia rate EnerGuide 80.5. Prior to segregation, BUILT GREEN® Gold homes in Alberta and British Columbia had an average ERS rating of 79. Albeit a small incremental increase in the ERS rating (since segregation), it is moving in the right direction, and moreover exceeds current building code standard in both said provinces.

On the matter of training, here again, the change seems to be misunderstood. To clarify, there is mandatory training. Given the letter ran prior to our formal launch announcement of our online training module, dated the week of February 17, we understand why there was misinformation. BUILT GREEN® Program Fundamentals, Module 1 is mandatory and was created to properly orient a builder company to succeed in the program. This module focuses on the fundamental aspects of the program, to orient participants on how to work with Built Green; introduce them to the administrative and technical requirements; prepare them to successfully navigate Built Green's quality assurance processes; and offer them resources to help them be successful at building BUILT GREEN® homes. Building Science training alone cannot achieve this. However, Built Green Canada encourages continued education and strongly recommends builders take the building science training offered – points may be earned on our 2015 Checklist.

The module was developed with input from the BUILT GREEN® Technical Standards Committee, as well as builder members, in keeping with the organization's "by builders, for builders" principle. Provided in an online format, participants may now complete the training at their convenience and are provided a 90-day window for completion. This addresses accessibility considerations for those in more remote communities. The new training course, aptly named Module 1, sets the stage for the development of future training modules, informed by industry requirements.

Finally, in response to your question about our credibility, and moreover, your concern about builders making mistakes in the "House as a System", we make the following comments: our program is third-party certified and is built around the "House as a System" approach, such that this is entrenched in the BUILT GREEN® program, as evidenced by our checklists.

As always, we welcome your feedback and questions. On that note, on February 5, we began our 2015 Single Family Checklist Draft: Public Consultation Process and would encourage builders to provide input directly to us by visiting *http://www.builtgreencanada.ca/2015-sf-checklist-consultation*.

Whether you're a supporter of Built Green Canada, LEED, R-2000, or another program, we commend you. Our intent here is to ensure clarity on the facts only. Each program offers the means for builders to build more sustainably and, after all, aren't we all working towards this common goal?

Built Green Canada
Edmonton, AB

Re: Editorial, Solplan Review No. 173 (Nov 2013)

Your fantastic journal hits my desk in its regular cycle, and gets batted around with the regular workload that fills my desk. I always end up finding some time to read through it, along with the two others still on my desk at most times, but then sadly end up either passing them to my team or recycle them and retain only what I remember from my brief read.

I am quite fond of continuing to learn and your publication provides great insight and research info. I thought "I wonder if this stuff is online that I can retain access to and search by topic should we encounter a situation that we want to read about". Then I read your editorial speaking of the lack of digitized past research, burning and shredding of our books and libraries…but when I look online I cannot find past articles or issues of Solplan Review, save for random references to them by others. I would love it if you catalogued and digitized all your past issues, providing a wealth of knowledge to both the industry and homeowners in search of the best building practices that could be searchable by topic so it's easily accessible either in the office, or in the field.

Help us keep this great info accessible so the research and information is neither lost, nor left unused.

BC
Toronto, ON

Thanks for the kind words. The question of why don't we publish electronically has come up before. There are a couple of reasons.

One is that, contrary to appearances, this is a very small operation with limited resources. Life has had a way of interfering, and available time resources have been stretched, so that we have not had a chance to erect even a simple web site, but it is something that will happen.

Secondly, we've stayed with print copies because this enterprise is economically marginal – we rely on subscription revenues to keep it going. Individual subscriptions and a bulk subscription for CHBA builder members is the mainstay. Few publications have as yet found a formula to make electronic publishing viable.

Third, the print copy is still very portable and accessible to all. It can be thrown into the truck and looked at on the job site or wherever, and be passed around a crew. You don't need special technology or conditions to access it.

Keen readers may also have noted that the publication date seems to be a couple of months out of sync with the calendar. There's been a fair bit of drama around here, and publication deadlines have slid, but we're committed to progressively catch up with the calendar.

Ed.

Re: Editorial, Solplan Review No. 173 (Nov 2013)

A brilliant "From the Editor" item in Solplan Review No. 173. It raises an important, thought-provoking subject that should get wider distribution. I've never considered the drawbacks of "digitizing" important information.

RP, Surrey

Energy Answers

Rob Dumont

A number of homes have used a combo system for providing both space and water heating. What do you think of that approach?

I have used a combo system for 28 years in a rental house that my wife and I own. A 36,000 BTU/hour natural gas-fired water heater provides a combination of water heating and space heating for the house. The house is superinsulated with R-36 walls, R-40/R-50 ceilings, R-28 basement walls, and R-12 beneath the basement floor slab. It is also well sealed with a heat recovery ventilator, and uses some passive solar heating through south-facing windows.

A picture of the north side of the house taken in mid-March 2014 is shown in Figure 1.

Figure 1. North side of the three-level split superinsulated house built in 1986 in Saskatoon that has a combo system.

The auxiliary space heat is supplied by a natural gas-fired, power-vented water heater, and the space heat is distributed by a water to air heat exchanger with a blower fan and warm air ducting throughout the house. The water to air heat exchanger with a blower is more commonly called a fan coil.Almost all cars use a similar system to provide heat to the interior of the car. (In cars, the waste heat from the motor is the source of the heat for the glycol.) The natural gas water heater in the house has a measured combustion efficiency of about 77%, and the design heat loss of the house, which has about 1800 square feet of finished floor area, is about 22,000 BTU/hr (6.4 kilowatts) at -35˚C. A photo of the water heater is shown in Figure 2. As the water heater is power-vented, there is no concern about backdrafting.

Figure 2. Power-vented natural gas water heater used with the fan coil. (36,000 BTU/hr input). This Combo System is used for water heating and space heating. The Fan Coil is the white box at the top of the picture. The system has been running for 28 years as of 2014

At one time the house had 6 people in it, and the tenants never complained about insufficient space heat or water heat in Saskatoon's climate except for one occasion when the 1/3 hp fan motor on the fan coil was replaced, and the centrifugal fan ran backward, providing insufficient air flow. (Even with the fan motor running backward, a centrifugal fan will still provide some flow, probably in the 35% of capacity range. Changing the wiring on the motor quickly solved the problem, allowing the rotation of the motor and fan to be in the proper direction.)

To reduce hot water consumption, I used low flow shower heads on the two showers in the house. I also did not use a set-back thermostat for space heating, as I was concerned that in the morning with several showers running there might not be enough heating capacity to bring the house temperature up if the outdoor temperature was cold

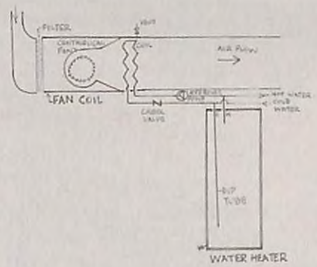


Figure 3. Schematic of the Combo System

Figure 4. Closeup photo of the coil in the fan coil. There are about 12 fins per inch.

The main components of the system, the water heater and the fan coil, have operated for 28 years with only a relatively small amount of maintenance – replacement of the power exhaust fan on the water heater, replacement of the water pump on the hydronic loop connecting the water heater to the fan coil, replacement of the direct drive 1/3 hp electric motor on the warm air fan, cleaning of the coil, replacement of the anode rod in the water heater every 7 years, and replacing the air filter on the fan coil about twice a year. I have also replaced the plastic dip tube on the water heater twice. The dip tube is the tube that brings cold water down to the base of the water heater and prevents cold water from directly exiting the top of the water heater. A better approach would be to have the cold water line enter at the base of the water heater; no dip tube would then be needed.

A picture of a dip tube, along with a replacement anode rod, is shown in Figure 5.

There are advantages and disadvantages to the combo systems.

Advantages

One water heater can provide both space heating and water heating in a house with a small spaceheating load.

Because the fan coil is suspended from the ceiling, a modest amount of floor space is saved by not having a floor mounted gas furnace.

By using two fan coils, one can have two separate space heating zones in the house.

If a very high efficiency condensing water heater is used, you have both high efficiency space heating and high efficiency domestic water heating.

Disadvantages

If the water heater stops working, you lose both water heating and space heating for the house. This happened in 2013 on our rental house, when the power venter on the exhaust gases for the water heater failed. Fortunately the house heat loss is small, and we were able to provide space heating by using four 1,500 watt plug-in space heaters which provided 20,500 BTU/hr until the water heater was back up and running. The passive solar gain from the south-facing windows also helped. Murphy's law also ensured that the problem occurred during the coldest winter Saskatoon has experienced in a long time.

Almost all homeowners and some plumbers/heating people are unfamiliar with the combo systems. One plumber/heating person who was called to the house for repairs said, incorrectly, that the system was unfixable and that there were no new water heaters that were approved for combo operation. Fortunately I was able to get a very experienced plumber (who also teaches at a local college) familiar with the system, and who was able to get replacement parts.

The house has a heat recovery ventilator that supplies outside air to the house. The supply air is connected to the return air side of the fan coil. The air filter on the exhaust air side of the HRV had become plugged, and in very cold weather there was no heat recovery on the supply air. The outdoor air temperature went down to -35˚C. This cold air was not heated by the HRV, and the cold air froze the pump inside the fan coil, causing the pump to leak water onto the floor in the mechanical room. Fortunately the coil did not freeze. The local supplier did not have a replacement pump, and had to order it in from another city.

The hydronic loop that brings hot water from the water heater to the fan coil requires a check valve to prevent hot water from thermosyphoning from the water heater to the fan coil when there is no demand for space heat. Over time the check valve became encrusted with scale from the minerals in the water. This prevented the check valve from fully closing. When the check valve does not fully close, hot water moves by natural convection from the water tank to the fan coil, and provides space heat when it is not requested by the room thermostat. I first noticed this when I was working in the house in the summer, and could hear the water heater cycling on and off even though there was no call for space heating or for domestic hot water.. This check valve failure has happened three times over the 28 year period of operation. In Figure 6, a photo of the inside of one of the check valves that has accumulated scale and other minerals is shown.

An alternative to the check valve is a U-shaped heat trap of pipe with at least an 18 inch deep U to prevent thermosyphoning of heat from the tank to the fan coil.

Another alternative that might work in some installations is to place the fan coil below the water heater.

Only a small number of companies now provide water heaters that are approved for use with combo systems.

The plumbing code now requires that a timer be put on the hydronic loop pump so that periodically the stagnant water in the coil is returned to the tank. This adds more complexity to the system. I suppose the reasoning behind this regulation is that someone might drink or ingest the stagnant water that sat in the coil for an extended period such as during the summer months when no space heat was required. Some combo water heaters incorporate a heat exchanger so that the potable water and the water used for space heating are separate.

The plumbing code now also requires that a mixing valve be placed on the output of the water heater so that the maximum temperature of the water delivered to the taps does not exceed about 122 ˚F (50˚C). The mixing valve adds complexity to the system, and another maintenance item.

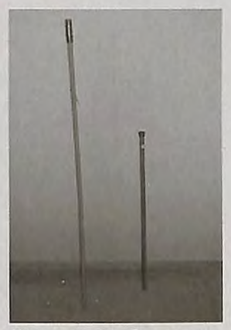


Figure 5. Replacement dip tube and anode rod for the water heater. The plastic dip tube is on the left, and the magnesium anode rod is on the right.

Figure 6. Photo of the check valve with the mineral scaling that prevents it from properly closing

The water coil in the fan coil must periodically be cleaned using an acid wash if potable water passes through the coil. Not many service personnel know how to do this.

The combo system space heat outputs are limited, and would not be suitable for a very large house. Most water heaters do not have a high enough capacity to provide both space heating and domestic hot water. For instance, one manufacturer's natural gas fired combo system water heaters range in size from 65,000 to 75,500 BTU/hr. For larger homes, a water boiler with a higher capacity would be required.

There are a number of unusual aspects to the combo systems. As with any system for supplying space heating or water heating, make sure that the components are reliable, regular maintenance is performed, and knowledgeable service people are available.

The Canadian Standards Association has a standard -- CSA P.9—and tested systems are now available (the standard was released in 2011) and is required for all combo systems as of April 1 in NRCan's Energy Star program. As a result, a number of manufacturers supplying Energy Star home builders are getting CSA P.9 test results for their systems and a few manufacturers have re-configured controls and pumps to achieve very high performance levels.

P.9 much like P.10 for integrated mechanical systems (on which it is based) assesses the performance of combination systems with an emphasis on part loads. It applies to tank based and tankless based systems.

NRCan has just recently released a bulletin to manufacturers who have tested to P.9 to report their results on a product listing that NRCan will be maintaining. NRCan anticipates several manufacturers will be posting their results immediately.

This is all in an effort to move the industry towards more efficient combination systems and to move away from site built systems with historical performance issues.

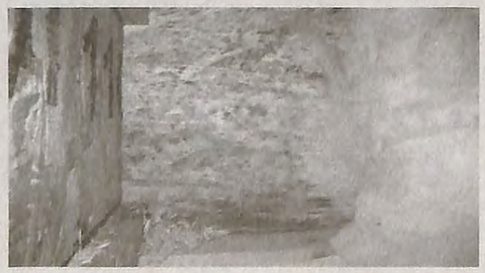
You Asked Us: About Mould and Moisture Problems at the Rim Joists

We have observed a number of instances where there is observed mould growth and moisture damage on manufactured wood rim joists. Typically, there is air leakage at this location as the header wrap is not sealed properly to the foundation wall, so that the leaking air hits the poly on the inside of the blanket of the insulation.

Is this an isolated case, or have you heard of other cases of accelerated mould growth on rim joists or similar other engineered wood products? If this is a problem, what type of economical treatment would minimize or prevent the growth of mould on engineered wood products when they are located in concealed locations where it is difficult to achieve 100% performing vapour barrier?

We are located in southern Ontario. This issue was discovered accidentally, during the course of investigating another problem.

MS, Toronto



We have not heard about this type of problem directly. However, air leakage through the building envelope is known to be a source of problems. It is a fundamental message that has been taught in builder courses from the inception of the training developed for the R-2000 program in 1982. The latest changes to Part 9 of the National Building Code of Canada, focusing on energy efficiency, have addressed air leakage by listing a number of common details that need to be addressed to ensure that the building envelope is more airtight.

The insulation in the rim joist area in this case was fiberglass batt, with a poly air and vapour barrier, and the rim joist was a manufactured wood piece. The moisture and mould was discovered by accident, when other work was being done in this general area. You make a comment about the location being one where it is difficult to achieve "100% vapour barrier". This suggests to me you are really pointing out to a poor air sealing detail rather than a problem with the vapour barrier. There is a difference, as vapour barrier continuity is usually not critical, but air barrier continuity is.

The accumulation of moisture suggests a fair bit of air leakage in the area to permit condensation and mould growth. Since the floor joists are I-joists, trying to rely on a piece of poly to air-seal the area is nearly impossible because the joist cavity is not a simple rectangle. I've never seen a well-sealed poly air barrier in that area.

The rim joist in your case is on top of the foundation wall and usually it will be below the neutral pressure plane of the house. This means that generally there will be air infiltration at that point, and not outward leakage. Infiltration generally means colder, dryer air which tends to dry materials rather than wetting the materials which is why this location has seldom been a problem even in houses that are not airtight.

The moisture accumulation on the rim joist suggests that the basement is being pressurized, pushing air out of the house through discontinuities in the air barrier which in this case is at the rim joist. Higher pressures in the basement are not uncommon with forced warm air heating systems because the ductwork often is poorly sealed and the ducting layout is not designed properly, so the pressurized ducts are leaking air into the basement, increasing the pressure relative to other parts of the house.

Another point to consider is that manufactured wood products are more susceptible to moisture problems when exposed to continued high moisture levels because of the larger surface area of exposed end-grain. Although the adhesives and coatings used in their manufacture generally seal the end-grain, that is not a long lasting protective coating.

This was observed on the West Coast a number of years ago when the causes building envelope failures were investigated. It was found that OSB (oriented strand board) materials deteriorated much quicker than plywood, with the result that builders on the West coast today use plywood much more frequently than they did in the past.

Properly detailed engineered wood products will perform well equally well, but they have less margin of safety for error.

If readers have seen this kind of situation, please let us know. We will pass the information on to agencies that could undertake research into the problems and develop remedial options and details to avoid the problems.

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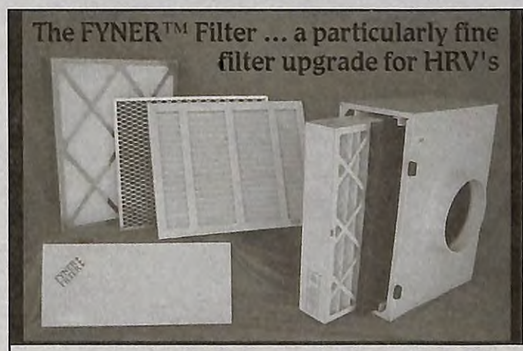

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